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How Effective is the Diabetes Prevention Program at Preventing Diabetes? A Survey of YMCA's Diabetes Prevention Program Participants Five Years Post-Completion

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Abstract

Objective**:** In people with prediabetes, a mere 5% weight loss can cut the risk of developing type 2 diabetes in half. In 2011, the YMCA of Greater Dayton launched the YMCA's Diabetes Prevention Program (YMCA's DPP) to reduce the prevalence of diabetes in Dayton, Ohio. In 2016, health data for the 2011 YMCA's DPP prediabetic cohort, including 2016 diabetes status, were evaluated.

Methods**:** Using de-identified YMCA of Greater Dayton data, analysis was performed on 2011 program (*N*=90) and 2016 survey results (*N*=21). The incidence of program 5% weight loss ("success") was determined and variables associated with success were identified. Survey results were used to calculate the 2016 incidence of diabetes.

Results**:** The cohort's program year-end mean weight loss was 6.4%. The incidence of success by 16 weeks was 44% (*n*=40) and 24% (*n*=22) at 12 months. Success was highest among females (I=50%, OR=1.8) aged 56 to 65 years (I=45%, OR=3.3) who attended class at a YMCA (I=54%, OR=2.4). Significantly higher class attendance, food journal submissions, and physical activity minutes were reported by successful program participants. In 2016, 71% (*n*=15/21) of 2011 YMCA's DPP respondents reported no diabetes diagnosis.

Conclusions**:** YMCA's DPP success was highest for women aged 56 to 65 years and those with more class attendance, food journal submissions, and physical activity minutes. Although a larger sample is needed, most survey respondents avoided diabetes by five-year follow-up. This finding suggests that the YMCA of Greater Dayton's DPP has outcomes at least similar to published longitudinal studies.

Keywords: weight loss, physical activity, food journals, attendance, Dayton

How effective is the Diabetes Prevention Program at preventing diabetes? A Survey of YMCA's Diabetes Prevention Program Participants Five Years Post-Completion

The Centers for Disease Control and Prevention (CDC) reported that over 29 million Americans have diabetes and that this number is increasing by over one million newly diagnosed cases each year (Centers for Disease Control and Prevention [CDC], 2015). Diabetes is the seventh leading cause of death in the nation and diabetic complications that include lowering an individual's life expectancy by up to 15 years and doubling to quadrupling their risk of heart disease: it is the leading cause of kidney failure, lower limb amputations, and adult-onset blindness (CDC, 2015). Healthy People 2020 identified the goals of reducing both the occurrence of and the economic burden of diabetes and improving the quality of life for individuals who have or are at risk of developing type 2 diabetes (United States Department of Health and Human Services [HHS], 2017). These goals are in response to the increasing prevalence of type 2 diabetes in the U.S. and both the human costs and the total financial costs associated with the disease (HHS, 2017).

In addition to the 29 million Americans already diagnosed with diabetes, the CDC reports another 86 million Americans (one in three adults) have prediabetes and only about 10% of these individuals are aware of their condition (American Medical Association [AMA] & CDC, 2014). Prediabetes is a health condition in which an individual's blood glucose is elevated, but is not yet in the diagnostic range for diabetes (see Table 1). The risk of these individuals developing type 2 diabetes is four to twelve times higher than that of adults with normal glucose levels (Ali, Echouffo-Tcheugui, & Williamson, 2012). Every year, 11% of prediabetic individuals become diabetic. The most recent estimated prevalence of Americans who either have diabetes or prediabetes is 33% (CDC, 2015).

Table 1

Blood Glucose Levels for Diagnosing Diabetes

Blood Test	Normal	Prediabetes	Diabetes
Fasting Plasma Glucose	< 100 mg/dl	100 mg/dl to 125 mg/dl	≥126 mg/dl
Oral Glucose Tolerance Test	<140 mg/dl	140 mg/dl to 199 mg/dl	≥ 200 mg/dl
Hemoglobin A1C	< 5.7%	5.7% to 6.4%	≥ 6.5%

Source: Verbatim from American Diabetes Association (ADA), 2016, top figure.

The estimated cost of diagnosed diabetes as of 2012 was $245 billion, which includes $176 billion in direct medical costs and $69 billion in reduced productivity (American Diabetes Association [ADA], 2013). As the number of Americans with diabetes or prediabetes continues to increase, the economic burden will also continue to rise. In order to reduce the cost burden as well as the loss in quality of life that diabetes presents, population-based strategies for identifying and preventing the development of diabetes need to be implemented. Clinical trials have shown that the onset of diabetes can be delayed and possibly prevented in many at-risk individuals through weight loss and increased physical activity (Davidson & Kahn, 2014).

In 2002, the CDC created the National Diabetes Prevention Program (NDPP) to align both public and private organizations in the effort to reduce the prevalence of prediabetes and type 2 diabetes in the U.S. (CDC, 2016); its national status was formalized by the United States Congress in 2010 in the Patient Protection and Affordable Care Act. The CDC also introduced a year-long curriculum called the Diabetes Prevention Program (DPP) focused on helping individuals with prediabetes delay or prevent the onset of type 2 diabetes through modest lifestyle change (CDC, 2016). Research has shown that program participants can reduce their risk of developing type 2 diabetes through a minimum 5% weight loss (CDC, 2016).

The National Institutes of Health (NIH) has funded research regarding the long-term effectiveness of the original DPP in preventing the onset of diabetes at three years and ten years post-program completion (CDC, 2016). Results have shown a 58% reduction in diabetes among DPP participants (71% for individuals 60 and older) who made lifestyle changes and lost the recommended five to seven percent body weight (CDC, 2016). Even after 10 years, these individuals were one-third less likely to develop type 2 diabetes compared to participants who did not adopt lifestyle changes (Knowler, Fowler, & Hamman, 2009). This result is based on study participants who were randomized into the lifestyle intervention and received intensive, individualized counseling and motivational support to assist in developing effective diet, exercise, and behavior modification (HHS, 2008). Limited research has been done on the long-term effectiveness of the DPP since its 2003 dissemination to group-based, community settings. To date, there has been little published research on the long-term health outcomes from community-based DPPs to see if they meet the effectiveness reported in multi-site research. The three-year demonstration grant results for the first YMCA's DPP in 2003 (Ackermann, 2013) and the Centers for Medicare and Medicaid Services (Alva, Hoeger, Jeyaraman, Amico, & Rojas-Smith, 2017) showed that the DPP could be effectively disseminated into a community setting. However, longitudinal program results have not been published.

Background

In 2011, the YMCA of Greater Dayton launched the YMCA of the USA's CDC-accredited *YMCA's Diabetes Prevention Program* (http://www.ymca.net/diabetes-prevention) at nine area locations. There were 90 participants who completed the program between 2011 and 2012. At the completion of the year-long program, the average weight loss for these 90 participants was 6.4% (± 6.03%). In 2016, the YMCA of Greater Dayton mailed a survey to

these 90 program participants, inquiring about their current health status, and particularly, if they had developed type 2 diabetes to date. The survey also asked questions about factors expected to be associated with the participants' initial weight loss success and long-term weight loss and healthy lifestyle maintenance. Data available from the 2011 program records included age, sex, class location, class attendance, submission of food journals, reported physical activity minutes, and percentage of weight loss at both 16 weeks and program completion (12 months).

The YMCA made the de-identified 2016 survey data and matching de-identified data from the 2011 to 2012 classes (age, sex, class location, class attendance, submission of food journals, reported physical activity minutes, and percent of weight loss) available for this study. An analysis was performed to evaluate the self-reported five-year outcomes within the context of factors that the literature identified as important to individuals' initial and long-term success in the YMCA's Diabetes Prevention Program (YMCA's DPP).

Statement of Purpose

The purpose of this report was to determine the effectiveness of the YMCA's DPP in preventing the onset of type 2 diabetes compared against the published incidence reduction of 58% at three years post-program completion (Knowler et al., 2002). Analysis of de-identified 2011 DPP participant data was conducted to describe characteristics that the literature associated with successful weight loss. Survey results from 2016 were analyzed to determine the program's long-term effectiveness and to compare each participant's initial weight loss and associated DPP class factors with their five-year health outcome to provide the YMCA insight for greater program success.

Literature Review

This literature review describes the chronology of the Diabetes Prevention Program and its nationwide dissemination. Factors for short-term and long-term program success are also identified.

The Diabetes Prevention Program (DPP) and the Diabetes Prevention Program Outcomes Study (DPPOS)

The DPP was first conducted between 1996 and 1999 as multi-center clinical research study funded by the NIH and overseen by the Diabetes Prevention Program Outcomes Study (DPPOS) (2017). The purpose of the DPPOS was to compare the effectiveness of lifestyle interventions such as diet modifications and increased physical activity on its ability to prevent or delay the onset of type 2 diabetes compared with metformin use and a placebo group. The DPPOS (2017) has published over 100 manuscripts (https://dppos.bsc.gwu.edu/web/dppos/welcome) regarding the DPP and its health outcomes (see Table 2 for funding sources). Based on the DPP's success, this program became the basis for the National Diabetes Prevention Program (National DPP) that is overseen by the CDC (CDC, 2016).

Table 2

Diabetes Prevention Program Outcomes Study (DPPOS) Funding Sources

American Diabetes Association (ADA)
Centers for Disease Control and Prevention (CDC)
Indian Health Service (IHS)
National Cancer Institute (NCI)
National Eye Institute (NEI)
National Heart, Lung and Blood Institute (NHLBI)
National Institute on Aging (NIA)
National Institute of Child Health and Human Development (NICHD)
National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)
National Institute on Minority Health and Health Disparities (NIMHD)
Office of Research on Women's Health (ORWH)

National DPP Design Elements and Implementation

The DPP is a year-long program that focuses on helping participants lose and maintain loss of five to seven percent of their baseline body weight in a group-based setting facilitated by a certified lifestyle coach (CDC, 2016). During the first 16 weeks, individuals meet weekly and are taught problem-solving, stress-reduction, and coping skills in addition to approaches for healthier eating. These practices are reinforced through weekly food journal submissions and reporting completed physical activity minutes. While physical activity is encouraged, it is not completed as a class (AMA/CDC, 2014). Participants are weighed at the beginning of each class to track changes in weight throughout the program. Following completion of the 16 weekly classes, participants attend a series of four bi-weekly classes and then six monthly maintenance classes to receive additional support in maintaining healthy lifestyle changes (CDC, 2016).

For an individual to be enrolled in a CDC-accredited DPP, they must meet the criteria outlined in Table 3. The National DPP allows for up to 50% of class participants to be enrolled based on results from the CDC's Prediabetes Screening Test (see Appendix A) rather than a blood test result. This assessment considers risk factors such as family history of diabetes, age, BMI, and previous diagnosis of gestational diabetes. Adult individuals who score nine or higher are eligible to participate in a DPP (AMA/CDC, 2014).

Table 3

Diabetes Prevention Program (DPP) Eligibility Requirements

Eligibility requirements for DPP enrollment:

• Be at least 18 years old **and**
• Be overweight (body mass index ≥24 (≥25 for the YMCA's DPP); ≥22 if Asian) **and**
• Have no previous diagnosis of type 1 or type 2 diabetes **and**
• Have a blood test result in the prediabetes range within the past year:
  o Hemoglobin A1C: 5.7%–6.4% **or**
  o Fasting plasma glucose: 100–125 mg/dL **or**
  o Two-hour plasma glucose (after a 75 gm glucose load): 140–199 mg/dL **or**
  o Be previously diagnosed with gestational diabetes **or**
• Score higher than nine on the CDC's Prediabetes Screening Test

Source: Following https://www.cdc.gov/diabetes/prevention/lifestyle-program/deliverers/eligibility.html

YMCA's Diabetes Prevention Program (YMCA's DPP)

In 2003, following the initial success of the DPPOS, the CDC began looking for opportunities to test the adaptability of the DPP as a community level intervention (Ackermann & Marrero, 2007). The YMCA of the USA was identified as an established, community-based organization with a history of developing and implementing health and wellness programs (Ackermann, 2013). The Y of Greater Indianapolis was selected as a pilot location to determine

if the DPP could be replicated with high fidelity to the DPP model in a non-health care setting. A cluster-randomized trial was designed involving 92 participants and two Indianapolis YMCAs (Ackermann, Brizendine, Finch, Marrero, & Zhou, 2008). The pilot achieved a 6% mean weight loss among program participants after six and 12 months (Ackermann, 2013).

Due to the pilot program's success, the YMCA's DPP has now been disseminated to almost 100 YMCA's throughout the U.S. Over 14,000 individuals have participated in the program and more than 1,500 lifestyle coaches have been trained (Diabetes Prevention Program Outcomes Study [DPPOS], 2017).

CDC-Accredited DPPs using the National DPP

Based on the demonstrated success of the DPP and its ability to be implemented at the community level, the United States Congress introduced the Diabetes Prevention Act of 2009 to grant the CDC authorization to establish a National DPP: this authorization was moved into the Patient Protection and Affordable Care Act (2010; National Conference of State Legislatures, 2011). CDC-accredited DPPs have since been established throughout the country. Community locations such as health care clinics, community-based organizations, faith-based organizations, pharmacies, wellness centers, worksites, cooperative extension offices and university-based continuing education programs offer the DPP program (CDC, 2016). By increasing the availability of DPPs nationwide, more at-risk individuals can be assisted with making the necessary lifestyle modifications needed to decrease their risk of developing type 2 diabetes (Ali et al., 2012).

Dayton, Ohio has three CDC-accredited DPP programs run by Diabetes Dayton, Public Health-Dayton & Montgomery County, and the YMCA of Greater Dayton.[1] Prices for these

[1]See https://nccd.cdc.gov/DDT_DPRP/City.aspx?STATE=OH&CITY=Dayton

programs vary by location, but all follow the year-long curriculum of the DPP and are offered in a group-based setting facilitated by a trained lifestyle coach.

Variations of the DPP from the DPPOS

While there are many variations of the DPP that use the CDC's curriculum and therefore qualify for CDC accreditation, two large independent programs grown from the DPPOS research are discussed below. These programs have a similar goal of reducing the incidence of type 2 diabetes.

Group Lifestyle Balance™ from the University of Pittsburgh. In 2006, the University of Pittsburgh used their experience from the DPPOS to establish the Diabetes Prevention Support Center (DPSC) with funding from the Department of Defense (DOD). DPSC's mission is to prevent or delay diabetes and improve cardiovascular health through education, screening and lifestyle interventions (http://www.diabetesprevention.pitt.edu/index.php/for-the-public/). Similar to the DPP, the DPSC uses their own trademarked program called Group Lifestyle Balance™ that is a group-based year-long program focused on nutrition, activity and behavioral change. The DPSC works with both military and general populations to facilitate prevention services (University of Pittsburgh, 2017).

Indiana University DPP. In 2012, the Indiana University (IU) capitalized on their experience with the DPPOS and began offering their DPP curriculum at no cost to full-time IU faculty, staff, and their spouses. Their 16-week program is available on all IU campuses and online. Like the National DPP, IU's program is group-based with classes focused on educating participants on the role of calories and fat in their daily diet and the importance of physical activity (Indiana University, 2017).

The National DPP and the Centers for Medicare and Medicaid Services (CMS) Funding

As the demand for DPPs increase, the capacity, affordability, and long-term sustainability of prevention programs need to be considered (Ali et al., 2012). In response to these concerns, the Department of Health and Human Services's Centers for Medicare and Medicaid Services (CMS) awarded a Health Care Innovation Award to the YMCA of the USA to determine the cost effectiveness of the DPP program among CMS beneficiaries. Between 2013 and 2015, about 6,000 Medicare beneficiaries participated in the YMCA's DPP through 17 YMCA networks nationwide. The program results showed an average weight loss of 4.73% of baseline body weight for participants who attended at least four class sessions and an average loss of 5.17% for those who attended at least nine class sessions (Alva et al., 2017). These outcomes resulted in a significant reduction in Medicare spending, inpatient admissions and emergency department visits (Alva et al., 2017). The expected healthcare savings per participant over 15 months was $2,650 while the cost of the program was roughly $400 per participant (Carroll, 2016). Starting in 2018, CMS will utilize a reimbursement structure for CDC-accredited DPPs allowing for more wide-spread dissemination and sustainability of the DPP (Alva et al., 2017). Figure 1 shows the chronology of the DPP from inception through 2016.

Chronology of Diabetes Prevention Program					
1996-1999	2002	2003	2009	2010	2016
The Diabetes Prevention Program Research Group conducted a randomized clinical trial of adults at high risk of developing type 2 diabetes (DPPOS, 2017).	Researchers published results of the Diabetes Prevention Program-finding that individuals at high risk for diabetes could prevent or delay the disease with a lifestyle intervention that resulted in 5-7 percent weight loss (DPPOS, 2017).	The CDC partners with the YMCA of the USA to pilot the DPP at a community-level to test the adaptability of the program.	Congress introduced the Diabetes Prevention Act of 2009 to give the CDC authorization to establish a National Diabetes Prevention Program.	CDC launches the National Diabetes Prevention Program by partnering with private and public organization, authorized by the Patient Protection and Affordable Care Act.	Centers for Medicare and Medicaid Services (CMS) announces that the DPP will be covered for Medicare beneficiaries effective 2018.

Figure 1. Chronology of the Diabetes Prevention Program from 1996 to 2016.

The DPP and Weight Loss

The population-based health outcomes of the DPP are the focus of ongoing research, as this is a relatively new field of study using large trials of behavioral public health intervention. Nationally, participants have seen a reduction in the onset of type 2 diabetes by following the DPP curriculum outlined by the CDC. One analysis of DPP data indicated a 58% reduction overall in the number of new cases of diabetes[2] among DPP participants and a 71% reduction for those participants over age 60 (AMA/CDC, 2014). Evidence-based research funded through the NIH has shown that the 58% reduction in new diabetes cases can be attributed to the recommended five to seven percent weight loss encouraged in the DPP classes. This weight loss

[2]"Reduction" in incidence was based on expected incidence of transition from prediabetes to diabetes.

is achieved through low-fat (<25% fat) dietary intake and moderate-level physical activity (Ackermann et al., 2007).

In research performed by Ali, Echouffo-Tcheugui, and Williamson (2012), weight loss was identified as the most important factor in reducing the onset of diabetes. The researchers found that, for every kilogram of weight loss, the incidence of diabetes was reduced by 16%. According to Davidson and Kahn (2014), lifestyle intervention in the DPP resulted in the mean delay of four to five years in the development of type 2 diabetes. Davidson and Kahn (2014) also found that weight loss was the key factor that reduced the risk of type 2 diabetes and recommended that all prevention efforts should be focused on weight reduction.

Factors that Influence DPP Weight Loss Success

Factors for weight loss success within the DPP vary slightly from study to study, but the primary considerations are the participants' perceived threat of diabetes, class attendance, ability to self-monitor healthy and unhealthy behaviors, level of self-efficacy, and having a comparable peer group. Each of these factors are explained further in the sections below.

Perceived threat of developing diabetes. Communicating the risk of developing type 2 diabetes is an important stimulus for lifestyle change (Ali et al., 2012). Research shows that 71% to 82% of prediabetic individuals who are advised by their health care provider to make lifestyle changes attempt to do so (Ali et al., 2012). One study performed by Jokelainen, Keinanen-Kiukaanniemi, Oksa, Rautio, and Saaristo (2013) observed 3,880 individuals in Finland who had completed a year-long DPP. The study found that individuals who had an abnormal glucose test at the beginning of the program had an increased awareness of the risks of type 2 diabetes and the long-term consequences of the disease compared to participants without the abnormal result. This fear increased their motivation to make lifestyle modifications. Researchers concluded that

individuals are more likely to change their health behavior when they perceive an immediate threat to their health (Jokelainen, Keinanen-Kiukaanniemi, Oksa, Rautio, & Saaristo, 2013).

DPP class attendance. Ali et al.'s (2012) meta-analysis found that attrition from the DPP was related to participants' perceptions of how likely they were to get diabetes. The higher their individual diabetes risk, the greater an individual's attendance was at DPP classes. An individual's attendance at DPP classes has been shown to have a strong relationship with their ability to make lifestyle modifications during a DPP. Ali et al. (2012) showed that the magnitude of a participant's weight loss through diet modification was directly associated with the number and frequency of classes attended; or every additional DPP class attended, weight loss increased.

Additionally, a study within the Indiana University DPP demonstrated that weight loss and maintenance were enhanced by group social support (Ackermann et al., 2007). The study found that a group environment increased accountability for regular attendance as well as setting and attaining lifestyle modification goals, including those related to diet (Ackermann et al., 2007). Similar research conducted by Delahanty and colleagues (2014) found that younger and middle-aged individuals, particularly women, specifically benefit from social support. Group settings are used to address common barriers in the participants' daily routines and identify strategies for greater success with diet modifications.

Ability to self-monitor. As part of the DPP curriculum, participants are encouraged to self-monitor their weight, daily fat gram intake, and physical activity minutes and to submit that information weekly for feedback from their lifestyle coach (CDC, 2012). Research shows that participants who self-monitored their fat intake at least four times a week and achieved their weekly physical activity goal were significantly more likely to achieve the CDC-recommended five to seven percent weight loss. These two factors were independently associated with

participant weight loss success (Butcher, Hall, Harwell, Helgerson, & Vanderwood, 2011). Conversely, a study of DPP participants by Delahanty et al. (2014) found that 58% of participants reported problems associated with self-monitoring during the program; when not resolved with the lifestyle coach, problems with self-monitoring became the primary barrier for weight loss. Lower household income and less education were significantly associated with self-monitoring (Delahanty et al., 2014).

Level of self-efficacy. Self-efficacy, or an individual's belief in their ability to achieve a desired goal, also influences an individual's ability to make lifestyle modifications during a DPP (Ackermann, Finch, Hays, Marrero, & Saha, 2014). According to Ackermann, Finch, Hays, Marrero, and Saha (2014), weight loss self-efficacy is one of the most important modifiable, independent correlates of weight loss success and it has been proven to impact both short-term (six months) and long-term (12+months) outcomes. The study found that DPP participants' self-efficacy was significantly improved after completing the DPP's 16-week core curriculum. The authors discussed the need for participants to continue with self-efficacy in the long term. Following these weekly classes, participants are encouraged to work with their lifestyle coaches to develop action plans for diet modifications and physical activity that will enhance self-efficacy and problem-solving skills essential for sustaining successful lifestyle changes (CDC, 2012). Self-esteem and empowerment are intended by-products of the participant's increased self-efficacy (Ackermann & Marrero, 2007).

Comparable peer group. Access to a DPP class with a comparable peer group has been shown to increase an individual's ability to make lifestyle modifications during the program. Ali et al. (2012) found that effectively identifying and recruiting multiple class participants through channels that people can culturally relate to brings greater commitment to attendance and

implementation of diet modifications. In a study involving church-based DPPs, Confair et al. (2013) found that culture included not only the practical norms, beliefs, and experiences of the participants, but also their higher perception of spirituality and health connection. Their study showed that church-based DPPs could assist participants in making specific diet modifications based on the unique needs and beliefs of the self-selected group (Confair et al., 2013). These findings can also be applied to other DPP settings throughout the community and should be considered when establishing new classes and/or engaging new participant groups, such as immigrants from other countries.

Barriers that Effect DPP Weight Loss Success

Weight gain has been shown to have a strong relationship with an individual's risk for developing of type 2 diabetes. Halter, Lin, Resnick, and Valsania (2000) found that, compared to overweight people with stable weight, overweight people who gained weight had a greatly increased diabetes risk: each kilogram of weight gained annually over 10 years was associated with a 49% increase in risk of developing diabetes. Conversely, each kilogram of weight lost annually over the decade was associated with a 33% lower risk of diabetes (Halter, Lin, Resnick, & Valsania, 2000).

Arave et al. (2011) found that weight gain was most common among DPP participants who did not monitor their weight outside of class, engage in physical activity, or identify and correct poor dietary choices. Additionally, the participants who had weight gain more frequently reported specific barriers to weight loss such as emotional eating, stress, and exercise than participants who achieved weight loss during the DPP (Arave et al., 2011).

Factors for Preventing Weight Re-gain and Regression to Former Habits

In a longitudinal cohort study of individuals who had completed a DPP, Arave et al. (2011) found that self-monitoring, high levels of physical activity, and the ability to identify and correct dietary choices were significantly associated with participants who achieved or maintained weight loss (ranging from one to two years post-completion) compared to those participants who gained weight. Additionally, 59% of successful program participants reported using the above-mentioned weight maintenance behaviors (Arave et al., 2011). Research performed by Phelan and Wing (2005) also identified self-monitoring of weight, engagement in high levels of physical activity, and eating a low-calorie/low-fat diet as behaviors associated with weight maintenance. These three behaviors are discussed in the sections below.

Weight monitoring. During the program, DPP participants are weighed by a lifestyle coach at the beginning of each class. Participants are also encouraged by their lifestyle coach to monitor their weight outside of class to track progress in-between class sessions and to reinforce the skill of self-monitoring (CDC, 2012). Survey results from a study conducted by Arave et al. (2011) showed that 89% of DPP participants who achieved or maintained their weight loss goals one year after program completion reported regularly monitoring their weight.

Engagement in physical activity. Throughout the DPP, participants are asked to track and report their number of physical activity minutes per week with the goal of completing 150 minutes per week (CDC, 2012). Frequent exercise has been identified as one of the strongest correlates of successful weight loss maintenance (Befort et al., 2008). The study by Arave et al. (2011) found that only 33% of participants who maintained their weight reported exercise-related barriers, compared to 63% of participants who gained weight.

Ability to identify and correct dietary choices. Research by Arave et al. (2011) identified the importance of following a low-calorie and/or low-fat meal plan and eating breakfast regularly in an individual's ability to maintain his or her weight. Survey results showed that 61% of DPP participants who achieved or maintained weight loss followed a low-calorie meal plan, 71% followed a low-fat meal plan, and almost all regularly ate breakfast (94%) (Arave et al., 2011). Additionally, more successful program participants (84%) reported being able to identify and correct dietary choices before they resulted in weight gain than unsuccessful participants (56%) (Arave et al., 2011).

Need for Additional Research

Since the creation of the DPP, many studies have shown the effectiveness of lifestyle interventions at helping participants lose weight. These studies have been conducted at both the national and community level. With the exception of the 10-year DPPOS, the long-term health outcomes of DPP participants have not received the research funding or attention necessary to evaluate the program's long-term effectiveness. Additional research needs to be done to assess participants' success at weight maintenance and the long-term health outcomes of community-based DPPs (DPPOS, 2017).

Methods

Study Sample and Data Collection

In 2010, the YMCA of the USA began piloting their branded YMCA's Diabetes Prevention Program (YMCA's DPP) at specific YMCA's nationwide. The YMCA of Greater Dayton was identified as a potential site due to the prevalence of diabetes (13%) and prediabetes (8.3%) within the Dayton area (Ebron & Paton, 2014). A YMCA's DPP class was piloted in 2010 and it was fully integrated into the YMCA of Greater Dayton's program base in 2011. In that

year, nine classes were created with a total of 90 participants completing the program. At baseline, all participants were considered to have prediabetes based upon eligibility for the program. Participant data were collected throughout the year-long program and were entered into a secure database by the assigned lifestyle coach. The participant data included: age, gender, class location, baseline and longitudinal weight measures, class attendance, number of food journal submissions, number of reported physical activity minutes, percentage of weight loss at 16 weeks, and percentage of weight loss at 12 months.

In 2016, the YMCA of Greater Dayton created an independent survey (Appendix B) for these 90 participants to better understand the long-term health outcomes of the YMCA's DPP. The survey questions asked for the participant's current weight, height, diabetic status, eating habits, and physical activity habits, along with demographic information (race, income, and education).

The survey was sent to the 90 former DPP participants via standard U.S. mail in the fall of 2016. The initial mailing was sent to 89 participants (one participant had previously requested to not be contacted) and resulted in a response rate of 12% (n=11/89). Three weeks later, a second (identical) mailing was sent to the participants who had not responded. An additional 10 surveys were returned, resulting in a 24% response rate (n=21/89).

The survey results were entered into an Excel file by YMCA staff and matched with 2011 program results to create a single, longitudinal data set. The data were then de-identified and provided to this manuscript's author (RM) for the current analysis (Appendix C). These findings, along with an initial analysis of the participants' success in 2011, were the focus of this descriptive analysis.

Exempt Status of De-Identified Data Analysis

This study was considered 'exempt' under the ethical standards outlined in the United States Code Federal Regulations section 45 (see Appendix D for the decision tree used to determine this exempt status). This exempt status made review by the Wright State University Institutional Review Board unnecessary (http://www.wright.edu/research/compliance/human-subjects).

Statistical Analysis

Specific aims. This report had three purposes:

1. a) Describe the 2011 cohort and compare participants who lost the recommended amount of weight (successful) with those that did not (unsuccessful) in regards to demographics, incidence of program success, means of weight loss and program participation variables at 16 weeks and 12 months;

   b) Identify factors impacting program success at 16 weeks and 12 months.
2. a) Describe the 2016 survey respondents;

   b) Determine if 2016 survey respondents are representative of the 2011 cohort.
3. Assess the relationship between 2011 program success and 2016 diabetic status.

IBM SPSS Statistics software licensed to Wright State University was used for all analyses except calculated odds for specific aim 1a.

Variables and definitions. The data extracted from the YMCA of Greater Dayton's database of DPP participants included age, gender, percent of weight loss at specific DPP timepoints, class location, class attendance, submission of food journals and reported physical activity minutes. The 2011 data for this study included all 90 participants who completed the YMCA's DPP during 2011 (2011 cohort) using the variables as defined in Table 4.

Table 4

Variables Used in Analyses

Variable Name	Definition	
	2011	2016
Participant Age	Self-reported date of birth was entered into database where age was populated as a whole number.	Age ranges were provided and participants selected which range included their current age.
Participant Gender	Either self-reported over the phone or entered based on face-to-face conversation with participant.	Not reported on survey. Used 2011 data for analysis.
Participant Weight	Lifestyle coach weighed the participant before each class and recorded the number into the YMCA's DPP database.	Self-reported on survey.
Participant Height	Not recorded.	Self-reported on survey.
Participant BMI	Calculated by author using weight recorded in database and height self-reported on 2016 survey.	Calculated by author using self-reported height and weight from survey.
Percentage Weight Loss	Calculated by database (as either + or -) based on participant weights entered by lifestyle coach. Reported at 16 weeks and 12 months.	Calculated by author using last reported weight from 2011 data and self-reported weight from 2016 survey.
Class Location	Recorded by lifestyle coach.	Used 2011 data.
Qualifier for Participation	Recorded by program administrator as either risk assessment or blood work.	Not reported.
Payment Method	Recorded by program administrator at enrollment.	Self-reported on survey.
Diabetic Status	Prediabetic status was pre-requisite to participate in program-based on blood work or risk assessment results.	Self-reported on survey.
Class Attendance	Calculated by database based on number of times a participant's weight was entered by lifestyle coach. Determined by number of weekly classes attended (16 possible classes) and the number of monthly maintenance classes attended (8 possible classes).	Not reported.
Eating Habits	Number of food journal submissions entered into database by lifestyle coach. Options included 0 (no submission), .5 (partial), or 1 (complete).	Self-reported on survey.
Level of Physical Activity	Number of physical activity minutes reported each week by participant and entered into database by lifestyle coach. Analysis used cumulative number of minutes.	Self-reported on survey.
Successful in DPP	Achieved a minimum 5% weight loss during the program as calculated by database.	Based on 2011 data.
Current Medical Care	Not recorded.	Determined by self-reported response to whether the participant had seen a physician in the past 12 months OR if they have an A1C or fasting blood glucose result from within the last 12 months.
Household Income	Not recorded.	Self-reported based on income ranges.
Level of Education	Not recorded.	Self-reported based on education ranges.
Race	Self-reported as open-ended question.	Self-reported based on selection of race category.

Statistical methods to meet specific aims.

Specific aim 1a. Describe the 2011 cohort and compare weight loss success among program participants. The first step of this analysis was to describe demographics for the 2011 cohort. The results were then compared to means for local and national YMCA's DPP class averages from the past five years reported by the YMCA of Greater Dayton (2015). The 2011 cohort means were calculated in order to identify the incidence of achieving the recommended 5% weight loss during the program (success) at both 16 weeks and 12 months. These 'successful' participants were compared with those who did not achieve the recommended 5% weight loss (unsuccessful) using Independent t-tests. Incidence and odds of weight loss success by gender, age and class location were also calculated.

Specific aim 1b. Identify factors impacting program success at 16 weeks and 12 months. Logistic regression was used to analyze the relationship between frequency of class attendance, number of food journal submissions and reported physical activity minutes and program outcomes (success or unsuccessful).

Specific aim 2a. Describe the 2016 survey respondents and 2b. Determine if 2016 survey respondents are representative of the 2011 cohort. Using both 2011 data and 2016 survey results, demographics of survey respondents were identified. In order to determine if the 2016 survey respondents were representative of the 2011 cohort (DPP participants), one-sample t-tests were used to compare the means between the entire 2011 cohort (N=90) and means for 2011 data for 2016 survey respondents (N=21).

Specific aim 3. Assess the relationship between 2011 program success and 2016 diabetic status. Using survey results, frequency tables and means were calculated to determine the incidence of type 2 diabetes and reported changes in health habits among the 2016 survey

respondents. Independent t-tests were used to compare 2011 program means by 2016 diabetic status.

Results

Specific Aim 1a. Describe the 2011 Cohort and Compare Weight Loss Success among Program Participants

2011 cohort compared to other YMCA's DPPs. The YMCA of Greater Dayton and the YMCA of the USA reported mean demographic data for their respective program participants from August 2010 through September 2015 (YMCA of Greater Dayton, 2015). Those means are shown in Table 5 in comparison to the 2011 cohort means. The results indicate that the 2011 DPP classes offered by the YMCA of Greater Dayton achieved slightly higher weight loss percentages than the overall class averages reported by the YMCA of Greater Dayton and the YMCA of the USA for 2010 to 2015. The average percent weight loss for the 2011 cohort was consistent with the other local 16-week class results (4.8%) and higher at 12 months (6.4%). On average, the 2011 cohort had about 15% more male participants and the participants were between four to six years younger than the other two comparison groups. The recording of food journal submissions and physical activity minutes by the YMCA of Greater Dayton and the YMCA of the USA were not comparable and were therefore not analyzed for potential differences. Figure 2 shows the 2011 cohort by age group. Participants can be characterized as "middle aged': approximately two-third of participants were between the ages of 46 and 65 years.

Table 5

Demographic Data for the YMCA's Diabetes Prevention Program Classes

YMCA'S DPP Class	Mean Age	% Male	% Female	Mean # of Weekly Classes Attended	Mean # of Monthly Classes Attended	Mean % Weight Loss at 16 Weeks	Mean % Weight Loss at 12 Months
2011 Cohort YMCA of Greater Dayton	51.8	40%	60%	14.5	1.4	4.8%	6.4%
YMCA of Greater Dayton Class Averages (2010-2015)	58.0	26%	74%	14.3	1.7	5.1%	5.8%
YMCA of USA Class Averages (2010-2015)	56.0	23%	77%	12.6	1.6	4.6%	5.5%

Source: YMCA of Greater Dayton, 2015

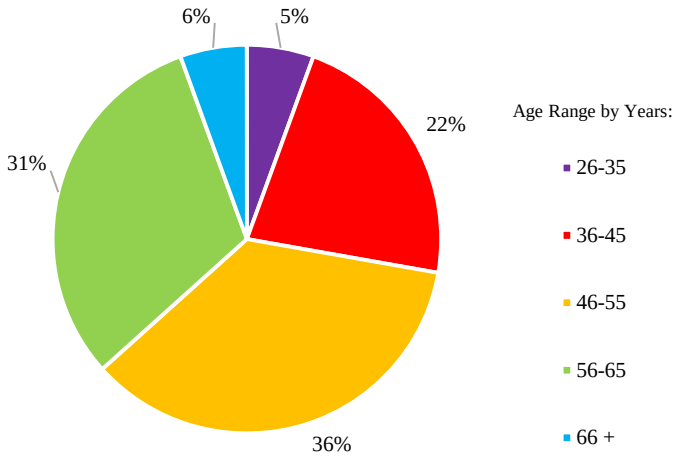

Figure 2. Percentage of participants by age group in 2011 cohort.

Characteristics of successful program participants at 16 weeks. Of the 90 program participants in the 2011 cohort, 40 individuals achieved the recommended 5% weight loss (success) by the end of the 16 weekly sessions, resulting in a 44% incidence of program success. Higher class attendance, frequency of food journal submissions, and physical activity minutes

were reported by successful participants and are discussed further in the next section. The mean percent weight loss at both 16 weeks and 12 months was higher for successful participants (8.63% and 9.95%) than unsuccessful participants (1.69% and 0.95%). Table 6 displays the mean data of the 40 successful individuals compared to the 50 unsuccessful individuals at 16 weeks.

Table 6

2011 Cohort Data by Weight Loss Success at 16 Weeks

	Successful at 16 weeks (*N*=40)			**Unsuccessful at 16 weeks (*N*=50)**		
	n	**Mean**	**SD**	***n***	**Mean**	**SD**
Mean starting weight 2011	40	223.39	43.37	50	219.43	45.26
Mean age 2011	40	52.75	9.29	50	50.98	10.02
*Mean # of weekly classes attended	40	15.60	0.87	50	13.60	4.00
**Mean # of monthly classes attended	40	1.98	1.93	50	0.92	1.37
***Mean # of food journal submissions	40	10.13	3.92	50	4.87	4.16
****Mean # of physical activity minutes	40	1609	1906	50	673	959
Mean 16-week weight	40	204.01	40.23	50	215.80	45.27
Mean % weight loss 2011 (16 weeks)	40	8.63	2.87	50	1.69	1.95
Mean 12-month weight	28	201.78	44.77	18	222.07	54.03
Mean % weight loss 2011 (12 months)	28	9.95	4.72	18	0.95	2.92

Note: *p=.003, **p=.003, ***p<.0005, ****p=.003. SD=Standard Deviation

Attendance, food journal submissions and reported physical activity minutes. Class attendance, food journal submissions and reported physical activity minutes were all variables of significance with weight loss success (p=.003, p<.0005, p=.003). Figures 3, 4, and 5 compare the differences in these three variables among the 40 individuals who achieved weight loss success at 16 weeks and the 50 individuals who did not. These charts show that on average, successful participants reported higher class attendance (two more weekly classes and 1.1 more monthly classes), more food journal submissions (5.2 more times) and a higher number of physical activity minutes (936 more minutes) during the 12-month program.

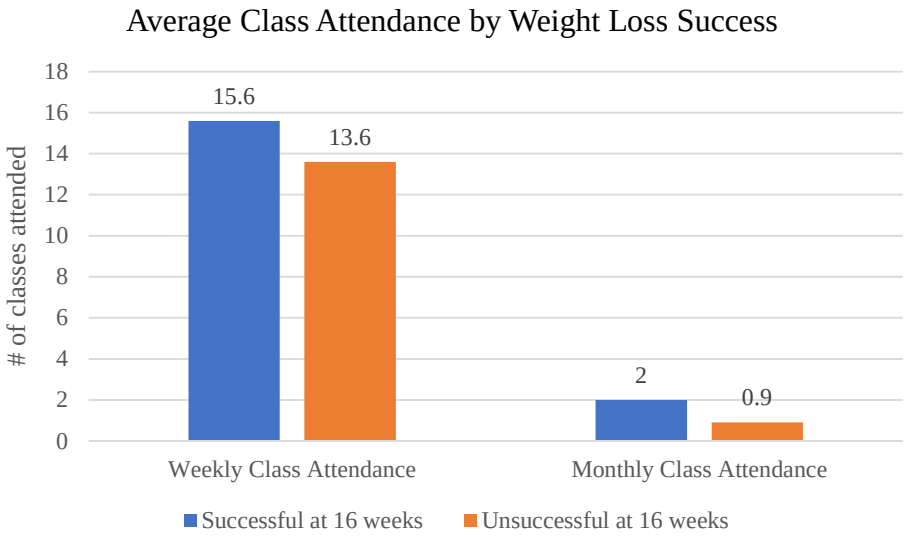

Figure 3. Average class attendance (cumulative) by weight loss success (16 weeks).

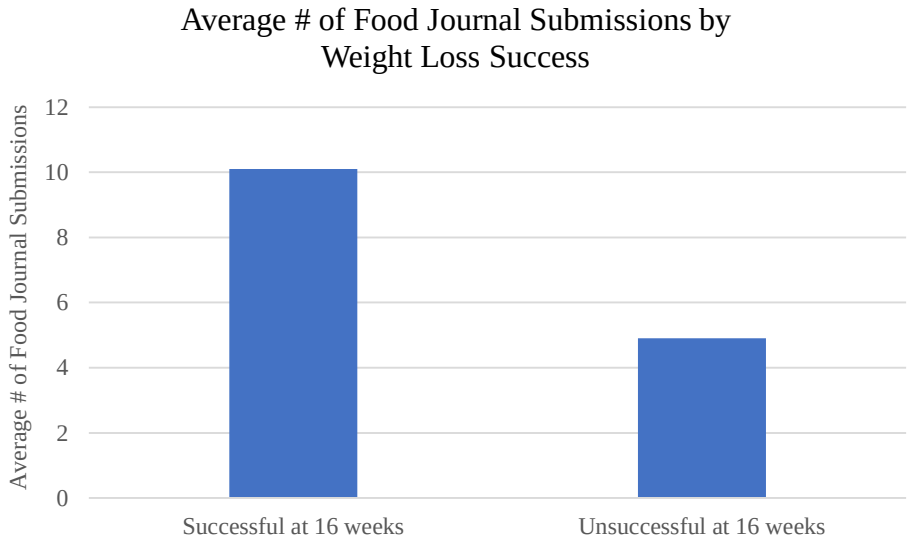

Figure 4. Average number of food journal submissions (cumulative) by weight loss success (16 weeks).

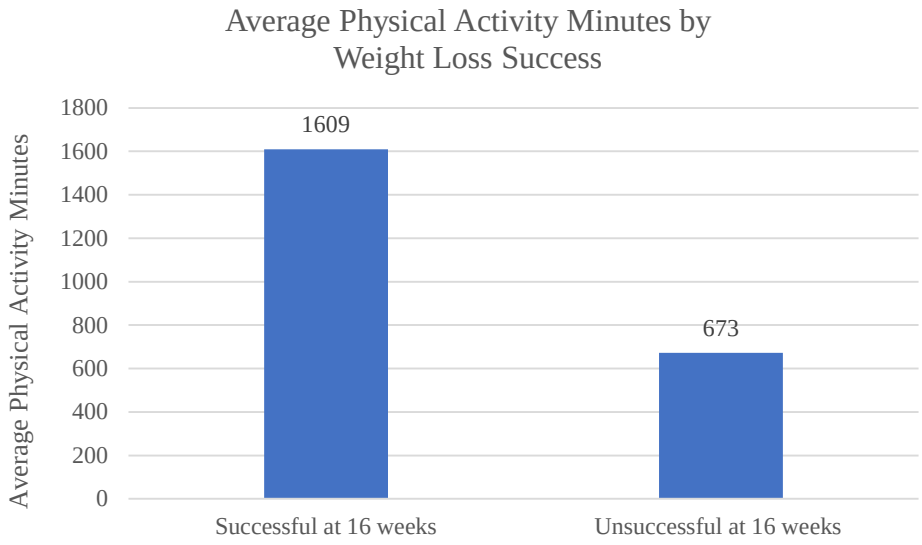

Figure 5. Average physical activity minutes (cumulative) by weight loss success (16 weeks).

In addition to the differences in attendance, food journal submissions and reported physical activity minutes between program success groups, program results for the two groups were also different in terms of gender, age and class location. The analyses of these three variables are shown below.

Gender. Females had a higher average percent weight loss than males at both 16 weeks (females=5.1%, males=4.3%) and 12 months (females=6.7, males=5.9). The incidence of weight loss success at 16 weeks and 12 months was greater for females (50%, 26%) than males (36%, 22%). The odds of weight loss success were 1.8 higher for females than males in the 2011 cohort. Table 7 compares mean 2011 cohort data by gender calculated using independent t-tests. The Fisher's exact 2-sided test was nonsignificant between genders for success at 16 weeks (p=0.28) and success at 12 months (p=1.00).

Table 7

2011 Cohort Data by Gender

	Male (*N*=36)			**Female (*N*=54)**			**All (*N*=90)**		
	n	**Mean**	**SD**	***n***	**Mean**	**SD**	***n***	**Mean**	**SD**
Mean age 2011	36	51.22	9.71	54	52.13	9.75	90	51.77	9.69
Mean # of weekly classes attended	36	13.89	4.07	54	14.91	2.40	90	14.5	3.20
Mean # of monthly classes attended	36	1.17	1.50	54	1.54	1.84	90	1.39	1.70
Mean # of food journal submissions	36	6.50	5.20	54	7.70	4.50	90	7.20	4.80
Mean # of physical activity minutes	36	1049	1758	54	1115	1359	90	1089	1522
Mean % weight loss 2011 (16 weeks)	36	4.29	4.37	54	5.10	4.12	90	4.77	4.21
Mean % weight loss 2011 (12 months)	16	5.86	6.10	29	6.73	6.10	46	6.43	6.03

Note: SD=Standard Deviation

Age. Weight loss success varied across the five age groups. Older participants (56 to 65 year-olds) had the highest percentage of weight loss at both 16 weeks (6.2%) and 12 months (9.3%), with a 64% success rate by 16 weeks. This group's calculated odds of success were 3.3 that of the other age groups. The odds of a participant aged 56 to 65 years achieving 5% weight loss was higher than all the other age groups combined (odds ratio=5.1). Table 8 compares mean 2011 cohort data by age group as calculated using independent t-tests. The Fisher's exact 2-sided test showed a marginal significance (p=.08) between participants based on age (younger than 56 versus those older than 56) for success at 16 weeks. This was not significant at 12 months (p=0.38).

Table 8

2011 Cohort Data by Age Group

	Age 26-35			**Age 36-45**			**Age 46-55**			**Age 56-65**			**Age 66 +**		
	N	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**
Mean # of weekly classes attended	5	15.80	0.45	20	15.20	1.36	32	14.25	3.72	28	14.25	3.34	5	13.4	5.27
Mean # of monthly classes attended	5	1.20	1.64	20	1.50	1.73	32	1.41	1.90	28	1.29	1.58	5	1.60	1.82
Mean # of food journal submissions	5	6.00	2.76	20	7.13	4.79	32	5.63	4.61	28	9.27	4.71	5	7.30	5.75
Mean # of physical activity minutes	5	582	481	20	991	1126	32	760	831	28	1599	2294	5	1237	1159
Mean % weight loss 2011 (16 weeks)	5	3.70	2.97	20	5.20	4.20	32	3.70	4.00	28	6.20	4.70	5	3.20	1.78
Mean % weight loss 2011 (12 months	2	2.70	1.13	12	5.40	6.30	13	5.70	5.90	16	9.30	5.80	3	0.90	2.67

Note: SD=Standard Deviation

***Class location*.** After categorizing the nine DPP locations as to either being a YMCA branch (*n*=6) or a worksite (*n*=3), the average percent weight loss was higher for YMCA facility DPPs at both 16 weeks (YMCA=5.4%, worksite=4.1%) and 12 months (YMCA=7.7%, worksite=5%). The incidence for weight loss success at 16 weeks was higher for YMCA facility DPPs (54%) than worksites (33%) and at 12 months (YMCA=29%, worksite=19%). The odds of those who attended a YMCA's DPP at a YMCA facility having weight loss success was more than double those of participants who attended a YMCA's DPP at a worksite (2.4:1). Table 9 compares mean 2011 cohort data by class location as calculated using independent t-tests. There was a significant relationship between success at 16 weeks and the class location (*p*=.048). The Fisher's exact 2-sided test showed a marginal significance (*p*=.06) between class locations for success at 16 weeks; this was not significant at 12 months (*p*=0.16).

Table 9

2011 Cohort Data by Class Location

	YMCA (*N*=48)			Worksite (*N*=42)		
	n	**Mean**	**SD**	***n***	**Mean**	**SD**
Mean age 2011	48	52.46	9.97	42	50.98	9.42
Mean # of weekly classes attended	48	14.77	2.94	42	14.19	3.47
Mean # of monthly classes attended	48	1.23	1.75	42	1.57	1.67
Mean # of food journal submissions	48	8.58	4.23	42	5.63	5.00
Mean # of physical activity minutes	48	977	845	42	1217	2045
Mean % weight loss 2011 (16 weeks)	48	5.37	4.41	42	4.10	3.92
Mean % weight loss 2011 (12 months)	24	7.70	6.05	22	5.04	5.82

Note: SD=Standard Deviation

Characteristics of successful program participants at 12 months. Twenty-two participants were categorized as successful in the DPP at 12 months; this is approximately half of the number of successful participants reported at the end of the 16 weekly classes (*n*=40), but this number was negatively impacted by 12 successful participants from week 16 who did not return for the 12-month weigh-in. All of those successful at 12 months were also categorized as successful at the end of the 16 weekly classes.

Of the 40 successful individuals from week 16, six gained weight by 12 months and were no longer at the recommended 5% weight loss. More females attended monthly classes (65%, *n*=30) than males (35%, *n*=16) and more females were successful at 12 months (64%, *n*=14) than males (36%, *n*=8). Additionally, more participants who attended a YMCA's DPP at a YMCA facility were successful (64%, *n*=14) than those that attended at a worksite (36%, *n*=8). Table 10 displays the results of independent t-tests of the 2011 cohort data by weight loss success at 12 months. Food journal submissions were significantly associated with weight loss success at 12

months (p=.003). The Fisher's Exact 2-sided Test showed that success at 16 weeks was significantly associated with success at 12 months (p=<.005).

Table 10

2011 Cohort by Weight Loss Success at 12 Months

	Success at 12 months (N=22)			Unsuccessful at 12 months (N=24)		
	n	**Mean**	**SD**	***n***	**Mean**	**SD**
Mean starting weight 2011	22	223.55	48.45	24	224.62	51.98
Mean age 2011	22	53.41	8.90	24	51.17	11.50
Mean # of weekly classes attended	22	15.59	0.503	24	15.67	0.637
Mean # of monthly classes attended	22	2.77	1.88	24	2.54	1.18
*Mean # of food journal submissions	22	11.14	3.84	24	7.29	4.39
Mean # of physical activity minutes reported	22	2066	2396	24	1096	1098
Mean 16-week weight	22	200.86	44.05	24	217.19	50.47
Mean % weight loss 2011 (16 weeks)	22	10.07	2.71	24	3.33	1.97
Mean 12-month weight	22	196.99	42.77	24	221.38	52.34
Mean % weight loss 2011 (12 months)	22	11.75	3.56	24	1.55	2.75

Note: *p=.003; SD=Standard Deviation

Specific Aim 1b. Identify Factors Impacting Program Success at 16 Weeks and 12 Months

A logistic regression was performed to analyze the association of gender, age, class location, class attendance, food journal submissions, and reported physical activity minutes with successful weight loss at 16 weeks. Adjusted measurements for covariates show food journals to be significantly associated with weight loss success (p=.003). The more food journal submissions participants had, the greater their odds of being successful in the program at 16 weeks. The results of the logistic regression are shown in Table 11.

Table 11

Logistic Regression of Variables by Weight Loss Success (16 weeks)

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Food Journal	0.236	0.081	8.557	1	**0.003**	1.267	1.081	1.484
Weekly Class Attendance	0.214	0.184	1.348	1	0.246	1.238	0.863	1.777
Activity Minutes	0	0	0.018	1	0.893	1	1	1
Gender (1=male)	-0.375	0.548	0.468	1	0.494	0.687	0.235	2.012
Age	0	0.027	0	1	0.997	1	0.947	1.055
Class Location (1=YMCA)	0.276	0.571	0.233	1	0.629	1.317	0.430	4.032
Constant	-5.286	3.243	2.657	1	0.103	0.005		

A logistic regression was also performed to analyze the significance of gender, age, class location, class attendance, food journal submissions, and reported physical activity minutes with successful weight loss at 12 months. Again, adjusted measurements for covariates show food journals were significantly associated with weight loss success (p=.041). The more food journal submissions participants had, the greater their odds of being successful in the program at 12 months. The logistic regression results are shown in Table 12.

Table 12

Logistic Regression of Variables by Weight Loss Success at 12 months.

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Food Journal	0.166	0.081	4.156	1	**0.041**	1.181	1.006	1.385
Weekly Class Attendance	0.158	0.161	0.972	1	0.324	1.171	0.855	1.605
Monthly Class Attendance	0.028	0.158	0.031	1	0.860	1.028	0.754	1.403
Physical Activity Minutes	0	0	0.532	1	0.466	1	1	1.001
Class Location (1=YMCA)	0.505	0.582	0.753	1	0.385	1.657	0.530	5.185
Gender (1=male)	-0.131	0.535	0.060	1	0.807	0.877	0.307	2.504
Age	0.005	0.027	0.040	1	0.842	1.005	0.954	1.060
Constant	-4.877	2.876	2.874	1	0.090	0.008		

Specific Aim 2a. Describe the 2016 Survey Respondents

Demographics of 2016 survey respondents. In 2016, twenty-one individuals from the 2011 cohort (24%) responded to a survey regarding their current health status. The responses provided demographic information that was not collected in 2011, including a height measurement that was used to calculate the individuals' body mass index (BMI). The survey results, including the respondents' demographics, are presented in Table 13. The data show that the majority of individuals who responded to the survey were White (81%), had at least some college education (72%), made at least $61,000 a year (43%) and were older (29% retired). Table 14 provides additional information regarding the 2016 survey respondents by gender. Males had

lower BMI at all three time points, better DPP weight loss at 16 weeks, and higher means for class participation variables (weekly and monthly classes attended, food journal submissions, and physical activity minutes).

Table 13

Demographics of 2016 Survey Respondents

Highest Level of Education (%)	
High school diploma	28.6%
Some college	23.8%
Bachelor's degree	42.9%
Graduate degree	4.8%
Household Income Range (%)	
Less than $20,000 per year	0.0%
$20,000-$40,000 per year	4.8%
$41,000-$60,000 per year	14.3%
$61,000-$80,000 per year	4.8%
Greater than $81,000 per year	38.1%
Retired	28.6%
Prefer not to answer	9.5%
Program Payment (%)	
Insurance	66.7%
Employer	9.5%
Self-pay	19.0%
Race (%)*	
White	81.0%
Black or African American	14.3%
Prefer not to answer	4.8%

*Although there were 7 options, respondents only chose these three

Table 14

2016 Survey Respondents' Characteristics by Gender

	Male (*N*=8)			Female (*N*=13)			All (*N*=21)		
	n	**Mean**	**SD**	***n***	**Mean**	**SD**	***n***	**Mean**	**SD**
Mean age 2011	8	53.25	12.23	13	55.46	7.94	21	54.62	9.56
Mean # of weekly classes attended	8	15.88	0.35	13	14.69	2.95	21	15.14	2.37
Mean # of monthly classes attended	8	2.00	1.69	13	1.54	1.98	21	1.71	1.85
Mean # of food journal submissions	8	11.06	4.00	13	9.12	3.2	21	9.86	3.56
Mean # of physical activity minutes	8	1312	1108	13	1172	829	21	1226	920
Mean % weight loss 2011 (16 weeks)	8	6.20	3.68	13	5.30	3.55	21	5.64	3.54
Mean % weight loss 2011 (12 months)	6	6.00	4.40	7	5.90	5.05	21	5.97	4.56
Mean starting BMI 2011	8	32.79	8.24	13	35.13	3.31	21	34.24	5.63
Mean ending BMI 2011	8	30.85	7.79	13	33.25	3.91	21	32.33	5.64
Mean BMI 2016	8	31.74	7.67	7	32.76	3.55	21	32.37	5.33
Mean % weight loss 2016	8	(-)3.63	6.41	7	1.08	9.76	21	(-).71	8.78

Note: SD=Standard Deviation

Specific Aim 2b. Determine if 2016 Survey Respondents are Representative of the 2011 Cohort

Comparison of 2011 cohort and 2016 survey respondents. Based on the survey response rate of 24%, a comparison of means was performed between the entire 2011 cohort (*N*=90) and the 2011 data for the 2016 survey respondents (*N*=21) to determine if the respondents were representative of the 2011 cohort. Table 15 shows the means for the two groups. One sample t-tests were performed to identify differences; the only significant difference (*p*=.003) was for a greater number of food journal submissions for the 2016 respondents compared with the overall 2011 cohort. Although not subjected to significance testing, the 2016 survey respondents also had a higher success rate at 16 weeks (57.1%) and 12 months (33%) than the 2011 cohort (44% at 16 weeks and 24% at 12 months). Gender ratios were similar

between the two cohorts, however, more of the 2016 survey respondents had class at a YMCA (81%) than the overall 2011 cohort (53%).

Table 15

Means of 2011 Cohort Compared to the 2011 Means for the 2016 Survey Respondents

	2011 Data for 2016 Survey Respondents			2011 Data for Entire Cohort		
	n	**Means**	**SD**	**n**	**Means**	**SD**
Mean starting weight 2011	21	218.57	43.73	90	221.19	44.22
Mean age 2011	21	54.62	9.56	90	51.77	9.69
Mean # of weekly classes attended	21	15.14	2.37	90	14.50	3.20
Mean # of monthly classes attended	21	1.71	1.85	90	1.39	1.70
*Mean # of food journal submissions	21	9.86	3.56	90	7.20	4.80
Mean # of physical activity minutes	21	1226	920	90	1089	1522
Mean % weight loss 2011 (16 weeks)	21	5.64	3.54	90	4.77	4.21
Mean % weight loss 2011 (12 months	13	5.97	4.56	46	6.43	6.03

Note: *p=.003; SD=Standard Deviation

Specific Aim 3. Assess the Relationship between 2011 Program Success and 2016 Diabetic Status

Diabetes status as reported by 2016 survey respondents. Survey results from the 2016 survey respondents showed that 71% (n=15) of the survey respondents had not developed type 2 diabetes in the five years post-program completion. Half of these individuals (n=7) were still prediabetic and the other half reported not being diabetic or prediabetic (n=8). In 2011, two-thirds (67%) of 2016 non-diabetics were successful at achieving 5% weight loss at 16 weeks; only one-third (33%) of the 2016 diabetics were successful. The majority (83%) of 2016 respondents self-reporting as diabetic were female and all were older than 45 years. Respondents self-reporting as non-diabetic had more 2011 physical activity minutes and a significantly higher

frequency of food journal submissions (p=.024). However, diabetics did have a slightly higher 2011 DPP attendance rate for both weekly and monthly classes. While both groups reported weight gain since 2011, their mean 2016 BMIs (diabetics=35.1, non-diabetics=31.3) were lower than their 2011 mean BMIs (diabetics=36.6, non-diabetics=33.3). Table 16 shows the participants' means based on diabetes status.

Table 16

2016 Survey Respondents Means Based on Diabetes Status

	Diabetic (*N*=6)			**Non-diabetic (*N*=15)**		
	n	**Mean**	**SD**	***n***	**Mean**	**SD**
Mean starting BMI 2011	6	36.60	3.00	15	33.30	6.20
Mean age 2011	6	53.50	8.70	15	55.10	10.20
Mean # of weekly classes attended	6	15.50	0.55	15	15.00	2.80
Mean # of monthly classes attended	6	2.70	2.40	15	1.30	1.50
*Mean # of food journal submissions	6	7.10	3.10	15	10.90	3.20
Mean # of physical activity minutes	6	1122.83	865.07	15	1266.60	967.73
Mean % weight loss 2011 (16 weeks)	6	4.65	3.63	15	6.03	3.54
Mean % weight loss 2011 (12 months)	4	4.93	6.30	9	6.43	3.93
Mean ending BMI 2011	6	35.10	4.13	15	31.25	5.92
Mean BMI 2016	6	35.10	3.17	15	31.30	5.70
Mean % weight loss 2016	6	(-).50	5.28	15	(-).80	10

Note: *p=.024

Table 17 shows reported health behaviors based on 2016 self-reported diabetes status. All diabetics reported seeing their physician in the past 12 months as well as having an A1C test. The majority of non-diabetic individuals (93%) also reported seeing their physician in the past 12 months. Approximately 50% of both groups reported that their current eating habits were 'not as good' as during their DPP participation, but 33% of non-diabetics reported that their eating habits

had 'improved' since the program. Two-thirds of diabetics reported that their current level of physical activity was 'not as good' as during their DPP participation, while that same percentage of non-diabetics reported their levels of physical activity were the 'same as' or 'improved' since the program.

Table 17

Reported Health Behaviors by Diabetes Status

	Diabetic (*N*=6)		**Non-diabetic (*N*=15)**	
Health Behavior	***n***	**% Within Group**	***n***	**% Within Group**
Current Medical Care (%):				
Has seen a physician in the past 12 months	6	100%	14	93.3%
Has had an A1C test done in the past 12 months	6	100%	10	66.7%
Has had a fasting blood sugar reading done in the past 12 months	5	88.3%	9	60.0%
Current eating habits (%):				
Not as good as during the program	3	50.0%	7	46.7%
The same as during the program	3	50.0%	3	20.0%
Improved from when I was in the program	0	0.0%	5	33.3%
Current level of physical activity (%):				
Not as good as during the program	4	66.7%	5	33.3%
The same as during the program	1	16.7%	4	26.7%
Improved from when I was in the program	1	16.7%	6	40.0%

A Fisher's exact 2-sided test of weight loss success at 16 weeks by diabetic status was non-significant (p=0.331). Due to the small sample size, a significance was not determined for differences in mean weight loss success at 12 months based on diabetic status and logistic regression was not attempted. Figure 6 is a cross-tabulation of 2011 weight loss success (at 16 weeks) and 2016 diabetic status. It shows that half of the survey respondents had success at 16

weeks and did not develop diabetes (*n*=10); only two respondents had success and later developed diabetes.

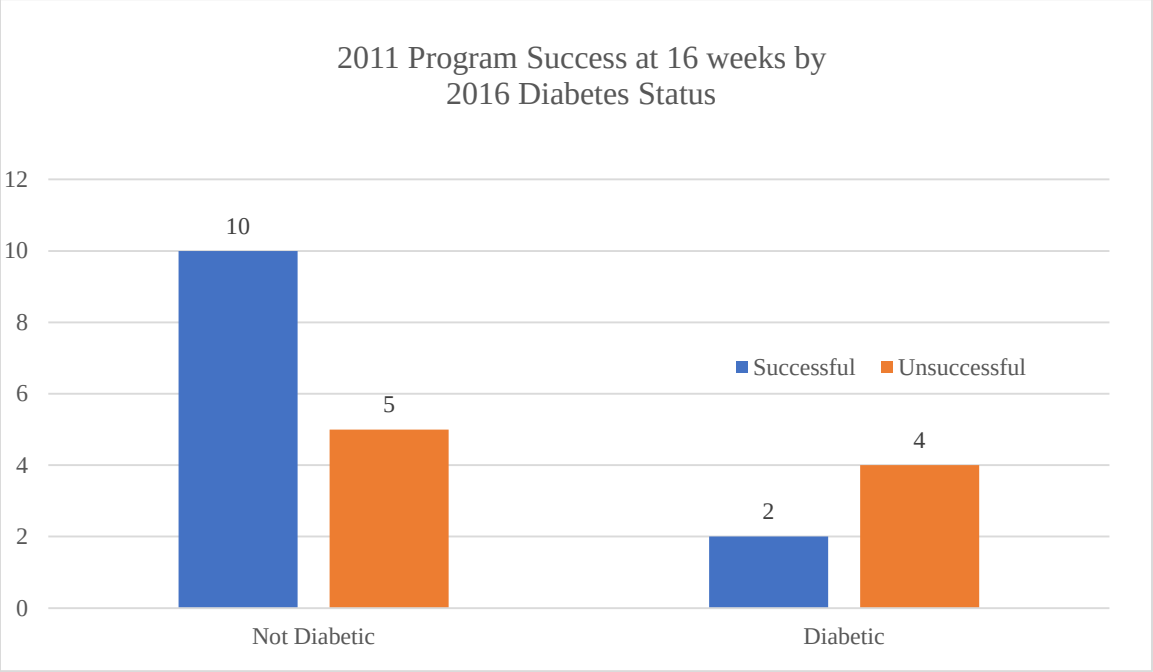

Figure 6. Cross-tabulation of 2016 diabetes status and 2011 success at 16 weeks.

Discussion

Program Success in 2011

Data showed that class attendance, frequency of food journal submissions and reported physical activity minutes were significantly associated with weight loss success during DPP participation. These results are consistent with data from other DPP studies: Ali et al. (2012) showed that the magnitude of a participant's weight loss was directly associated with the number and frequency of DPP class sessions attended. This relationship suggests that participants benefit from a classroom setting where they receive support from other participants and are held accountable for weekly weight loss efforts by their lifestyle coach. Research has shown that females are especially receptive to social support and that external accountability was considered necessary to provide motivation and support with weight loss (Metzsgar, Miller, Nickols-

Richardson & Preston, 2015). Females in the 2011 cohort had a higher attendance rate and success rate than the male participants.

The two primary lifestyle interventions emphasized in the YMCA's DPP are a reduction of daily fat gram consumption and an increase in physical activity. Food journaling assists participants in monitoring their daily fat grams and was a significant variable for weight loss success at both 16 weeks and 12 months. Butcher, Hall, Harwell, Helgerson, and Vanderwood (2011) found that DPP participants who self-monitored their fat intake were significantly more likely to achieve the recommended 5% weight loss. Participants who were successful in 2011 submitted their food journal an average of five times more than those that were unsuccessful. Based on logistic regression results, frequency of food journal submissions was the only variable significantly associated with weight loss success after controlling for the other covariates. Older participants (56 to 65 year-olds) had the highest program success rate and the highest frequency of food journal submissions. This suggests that this age group may have a greater engagement in the DPP activities and/or more time available to complete these activities.

An increase in physical activity is encouraged by the YMCA's DPP through a weekly report of participant physical activity minutes. Arave et al. (2011) found that successfully achieving physical activity goals was strongly associated with the probability of success at the end of a DPP. While the 2011 program had a wide range of reported physical activity minutes, successful participants (on average) reported significantly more physical activity minutes than those that were unsuccessful. These data also support the relationship between class location and program success: participants who completed the program at a YMCA facility had a higher rate of success. This could be due to having more immediate access to workout equipment (pre or

post class), comfort with using the workout facility, or other factors. Interviews with YMCA site participants and worksite participants could shed light on factors impacting this difference.

Relationship between 2011 and 2016 Survey Respondent Characteristics

While the 2016 survey response was only 24%, a comparison of means between the entire 2011 cohort and the 2011 data for the 2016 survey respondents showed comparable means for program variables as shown in Table 15. The only comparison that had a t-score of significance was the difference in mean number of food journal submissions. The 2016 survey respondents had a higher frequency of food journal submissions (9.9) than the overall 2011 cohort (7.2). While the difference was not subjected to significance testing, the 2016 survey respondents also had a higher success rate at both 16 weeks (57% versus 44%) and 12 months (33% versus 24%). These data suggest these participants had good self-monitoring and reporting skills that are also reflected by their survey completion. Research shows that participants who self-monitored their food intake were significantly more likely to achieve the CDC-recommended five to seven percent weight loss (Butcher et al., 2011).

Survey results 2016. The purpose of the 2016 survey was to determine the long-term effectiveness of the YMCA's Diabetes Prevention Program in preventing type 2 diabetes. DPPOS results show that successful program participants had a 58% reduction in the incidence of type 2 diabetes and those aged 60 years and older had a 71% reduction (AMA/CDC, 2014). Given the age range of the 2016 survey respondents, a higher than expected number of participants avoided the onset of type 2 diabetes (expected *n*: 58% of 24 = 14; observed *n*=15). As shown in Table 16, 71% of the respondents reported no diagnosis of type 2 diabetes at five years post-program completion.

Class attendance in 2011 was comparable between those 2016 respondents that had become diabetic and those that had not, however, the diabetic individuals had less food journal submissions and lower reported physical activity minutes. Diabetics also had a higher baseline BMI in 2011, which could affect their ability to prevent diabetes based on their bodies' condition at the start of the program. More female than male respondents reported having diabetes, which could be a result of weight gain due to the loss of group-based support. A weight loss study by the University of Illinois (Pedersen, 2015) found that most women in the sample struggled with self-motivation following a weight loss intervention and that not having social support was a significant struggle for weight maintenance. Long-term support groups could assist female participants in continued weight loss or maintenance that research associates with a decreased incidence of type 2 diabetes.

Additionally, 2016 survey results showed that 50% of diabetic participants reported that their 2016 eating habits were 'not as good' as during the 2011 program, and 66.7% reported that their 2016 level of physical activity was 'not as good'. Both of these factors are known to impact weight maintenance and overall health. Another important variable that could not be considered in this study design is the role of genetics and their influence on an individual's ability to prevent type 2 diabetes. This could be a factor for the individuals that developed diabetes but still achieved weight loss success (n=2) at the various benchmarks.

Limitations/Recommendations

Missing Variables and Data

In 2011, the YMCA did not consistently collect data for race or baseline BMI of program participants. Both values are now part of the initial participant paperwork but could not be considered for the 2011 participants who did not respond to the survey. Another limitation of the

data was the inconsistency in recording weight loss for all participants at year end. While it was required to attend and weigh-in at all 16 weekly classes, monthly maintenance class attendance was not emphasized in 2011 and the final weight for participants who stopped coming after 16 weeks only reflects four months of weight loss versus 12 months of weight loss. The YMCA of Greater Dayton now obtains year-end data for all participants.

Sample Size

The small sample size of the 2011 cohort and the low response of the 2016 survey respondents were also limitations to this study. While the trends are promising, a larger sample size is needed to allow for more robust statistical analysis. It is recommended that the YMCA of Greater Dayton continue to survey past program participants on a yearly basis to increase the sample size and allow for more in-depth analysis of program results, including potential effects of specific lifestyle coaches and temporal trends.

Recommendations

Based on this analysis, the YMCA of Greater Dayton and other DPP providers are encouraged to focus their efforts on emphasizing class attendance, food journal submission, and reporting physical activity minutes to program participants. Trends show that as values for these variables increase, a higher incidence of 5% weight loss occurs. Additionally, DPP coaches may want to tailor teaching methods to better assist younger male participants achieve a higher incidence of 5% weight loss.

Conclusion

Initial successful weight loss among the 2011 YMCA's DPP participants was highest for older women (aged 56 to 65 years) and those who attended more classes, turned in more food journals, and who reported more minutes of physical activity. Weight loss success at 16 weeks

was significantly associated with success at 12 months and non-diabetic survey respondents had a higher incidence of program success than diabetic respondents. Although a larger sample is needed, the majority of program participants who responded to the survey (15 of 21, or 71%) avoided diabetes by five-year follow-up. This suggests that the YMCA of Greater Dayton's Diabetes Prevention Program has outcomes at least similar to published longitudinal studies (~58% over five years).

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Appendix A: CDC Prediabetes Screening Test

CDC Prediabetes Screening Test

NATIONAL Diabetes PREVENTION PROGRAM

COULD YOU HAVE PREDIABETES?

Prediabetes means your blood glucose (sugar) is higher than normal, but not yet diabetes. Diabetes is a serious disease that can cause heart attack, stroke, blindness, kidney failure, or loss of feet or legs. Type 2 diabetes can be delayed or prevented in people with prediabetes through effective lifestyle programs. Take the first step. Find out your risk for prediabetes.

TAKE THE TEST—KNOW YOUR SCORE!

Answer these seven simple questions. For each "Yes" answer, add the number of points listed. All "No" answers are 0 points.

Yes	No	
1	0	Are you a woman who has had a baby weighing more than 9 pounds at birth?
1	0	Do you have a sister or brother with diabetes?
1	0	Do you have a parent with diabetes?
5	0	Find your height on the chart. Do you weigh as much as or more than the weight listed for your height?
5	0	Are you younger than 65 years of age and get little or no exercise in a typical day?
5	0	Are you between 45 and 64 years of age?
9	0	Are you 65 years of age or older?

Add your score and check the back of this page to see what it means.

AT-RISK WEIGHT CHART

Height	Weight Pounds	Height	Weight Pounds
4'10"	129	5'7"	172
4'11"	133	5'8"	177
5'0"	138	5'9"	182
5'1"	143	5'10"	188
5'2"	147	5'11"	193
5'3"	152	6'0"	199
5'4"	157	6'1"	204
5'5"	162	6'2"	210
5'6"	167	6'3"	216
		6'4"	221

National Center for Chronic Disease Prevention and Health Promotion
Division of Diabetes Translation

CDC

Appendix B: 2016 YMCA Survey

YMCA's Diabetes Prevention Program Survey

Please complete the following survey and return in the enclosed postage-paid envelope by **October 1, 2016**.

1. Id: _____

2. Current Age Range:
   ___ 26-35 years-old
   ___ 36-45 years-old
   ___ 46-55 years-old
   ___ 56-65 years-old
   ___ 66+ years-old

3. Current weight: _____

4. Current Height: _____

5. Have you seen a physician for a wellness check or physical in the past 12 months?
   ___ Yes ____ No

6. If yes, what is your current diabetes status?
   ____ Diabetic
   ____ Prediabetic
   ____ Not diabetic or prediabetic
   ____ Uncertain

7. Have you had a Hemoglobin A1C test done in the past 12 months? ___Yes ___No

8. If yes, what is your most recent value: _____

9. Have you had a fasting blood sugar reading done in the past 12 months?

10. If yes, what is your most recent value? _____

11. How would you describe your current eating habits?
   ____ Not as good as when I participated in the YMCA's Diabetes Prevention Program
   ____ The same as when I participated in the YMCA's Diabetes Prevention Program
   ____ Improved from when I participated in the YMCA's Diabetes Prevention Program

12. How would you describe your current level of physical activity?
   ____ Not as good as when I participated in the YMCA's Diabetes Prevention Program
   ____ The same as when I participated in the YMCA's Diabetes Prevention Program
   ____ Improved from when I participated in the YMCA's Diabetes Prevention Program

13. Have you attended more than one Diabetes Prevention Program?
   _____ Yes ____No

14. If yes, what location did you most recently attend for class?
_____ And what year?_____

15. What skills do you most remember from the YMCA's Diabetes Prevention Program?
_____
_____

16. What skills have you implemented from the YMCA's Diabetes Prevention Program?
_____
_____

17. Do you have any other comments regarding your experience with the YMCA's Diabetes Prevention Program?
_____
_____

Please select the best answer for each of the questions below:

How did you pay for the YMCA's Diabetes Prevention Program?
___ Insurance
___ Employer
___ Self-Pay

Household Income Range:
___ Less than $20,000 per year
___ $20,000-$40,000 per year
___ $41,000-$60,000 per year
___ $61,000-$80,000 per year
___ Greater than $81,000 per year
___ Retired
___ Prefer Not to Answer

Highest Education Level Achieved:
___ High School Diploma
___ Some college
___ Bachelor's Degree
___ Graduate Degree
___ Prefer Not to Answer

Race:
___ White
___ Black or African American
___ American Indian or Alaska Native
___ Asian
___ Pacific Islander
___ Other
___ Prefer Not to Answer

Appendix C: Data Permission Letter from YMCA of Greater Dayton

the YMCA

FOR YOUTH DEVELOPMENT®
FOR HEALTHY LIVING
FOR SOCIAL RESPONSIBILITY

February 1, 2017

To whom it may concern:

During the Fall of 2016, the YMCA of Greater Dayton conducted a survey regarding the long-term health outcomes of our YMCA'S Diabetes Prevention Program. The survey was mailed to 90 individuals who completed the YMCA's Diabetes Prevention Program 5 years ago. Our response rate was roughly 25%.

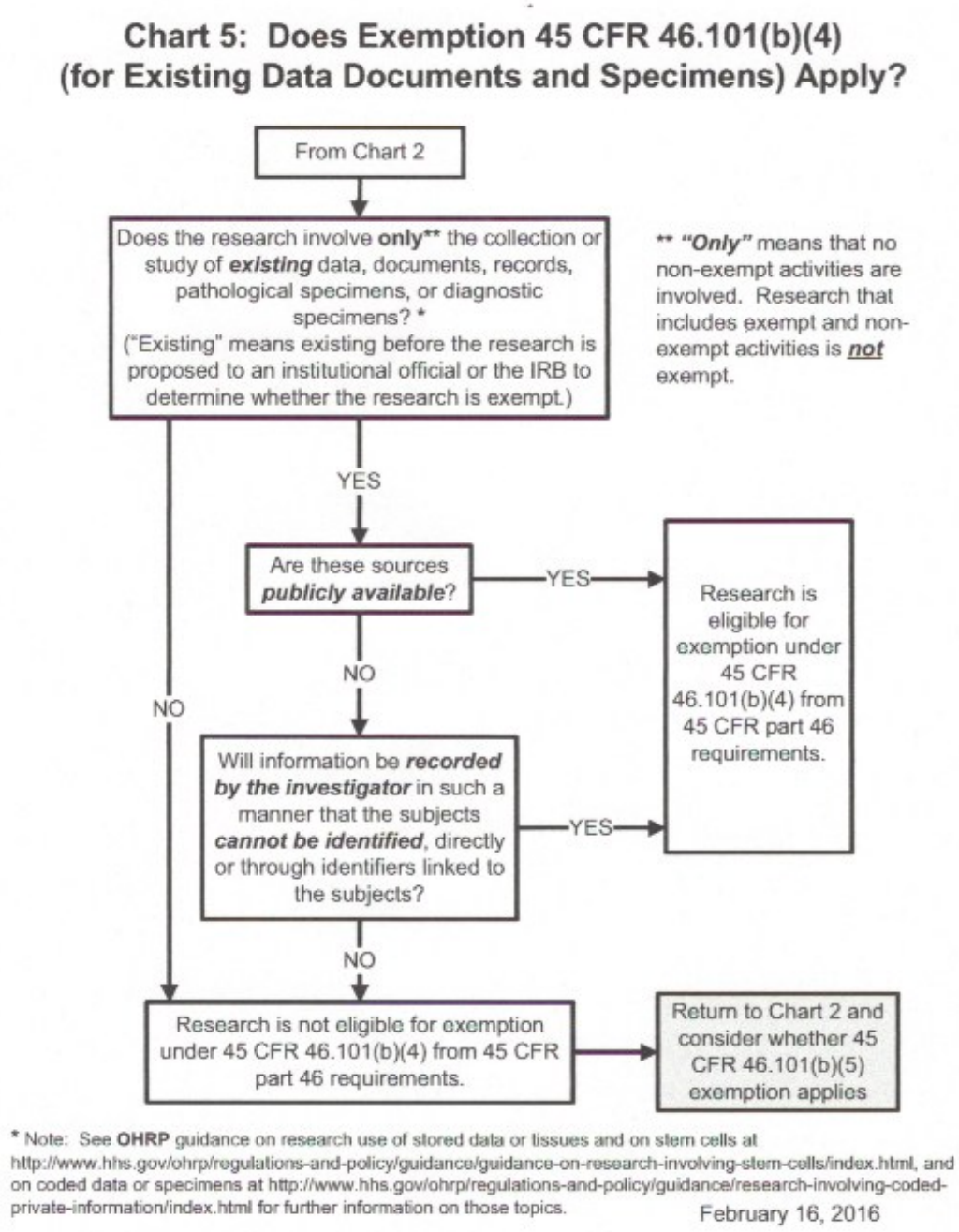
Now that we have collected these data, we are pleased that Rachael Mainord, a Wright State University graduate student in the Master of Public Health program, has agreed to analyze the results. We will provide her with de-identified survey responses that have been matched with the respondents' initial program results to be used for an aggregate report assessing the long-term health outcomes of the YMCA's Diabetes Prevention Program. We will also provide Ms. Mainord with de-identified summary demographic data for the entire sample of 90 individuals to whom the survey was sent so she can compare the respondents sample with the entire sample.

While we will be using the results to evaluate and improve our program offering, the YMCA of Greater Dayton understands that the results may also be beneficial to others working within diabetes prevention. We also understand that the data will be used for Rachael Mainord's culminating experience and as such will allow the findings to be published following ethical research policies and procedures as outlined by the Wright State University Institutional Review Board.

Sincerely,

Josh Sullenberger
Vice-President of Operations
YMCA of Greater Dayton

Appendix D: Decision Tree for IRB Exempt Status



Appendix E: List of Competencies Met in CE

Wright State Program Public Health Competencies Checklist

Assess and utilize quantitative and qualitative data.
Apply analytical reasoning and methods in data analysis to describe the health of a community.
Communicate public health information to lay and/or professional audiences with linguistic and cultural sensitivity.
Engage with community members and stakeholders using individual, team, and organizational opportunities.
Make evidence-informed decisions in public health practice.
Evaluate and interpret evidence, including strengths, limitations, and practical implications.
Demonstrate ethical standards in research, data collection and management, data analysis, and communication.

Concentration Specific Competencies Checklist

Health Promotion and Education:	
Area 1: Assess Needs, Assets and Capacity for Health Education	
1.1	Identify stakeholders to participate in the assessment process
1.2	Engage stakeholders to participate in the assessment process
1.4	Identify factors that foster or hinder skill building
1.6	Synthesize assessment findings
Area 2: Plan Health Education Programs	
2.3	Develop goal statements
2.4	Formulate specific, measurable, attainable, realistic, and time-sensitive objectives
2.7	Organize health education into a logical sequence
Area 3: Implement Health Education	
3.4	Evaluate training
Area 4: Conduct Evaluation and Research Related to Health Education	
4.1	Create purpose statement
4.2	Develop evaluation/research questions
4.3	Assess the merits and limitations of qualitative and quantitative data collection for research
4.4	Critique existing data collection instruments for research
4.6	Develop data analysis plan for research
4.7	Write new items to be used in data collection for research
4.9	Disseminate research findings through professional conference presentations
Area 5: Manage Health Education Programs	
5.7	Use communication strategies to obtain program support
5.9	Prepare reports to obtain and/or maintain program support
5.10	Synthesize data for purposes of reporting
5.17	Elicit feedback from partner(s)
Area 6: Serve as a health education resource person	
6.8	Use a variety of resources and strategies
6.9	Evaluate impact of training programs
6.10	Provide expert assistance
6.11	Evaluate the effectiveness of the expert assistance provided
Area 7: Communicate and advocate for health and health education	
7.4	Use evidence-based research to develop policies to promote health